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**Canapa**

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(54) **CONVEYING DEVICE**  
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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 208 days.

|                 |         |                                |
|-----------------|---------|--------------------------------|
| 6,422,785 B1    | 7/2002  | Ruggles et al.                 |
| 6,467,606 B1    | 10/2002 | Elent et al.                   |
| 6,481,563 B1    | 11/2002 | Gilmore                        |
| 6,655,893 B2    | 12/2003 | Kelly et al.                   |
| 6,752,261 B1 *  | 6/2004  | Gaeddert et al. .... 193/35 TE |
| 6,755,296 B2    | 6/2004  | Elwell                         |
| 6,893,200 B2    | 5/2005  | Thogersen                      |
| 6,935,487 B2 *  | 8/2005  | Schaum et al. .... 198/812     |
| 7,033,125 B2    | 4/2006  | Thogersen                      |
| 7,077,615 B2    | 7/2006  | Thogersen                      |
| 7,156,604 B2    | 1/2007  | Thogersen                      |
| 2003/0049107 A1 | 3/2003  | Thogersen                      |

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**B65G 15/26** (2006.01)  
(52) **U.S. Cl.** ..... **198/313**; 198/594  
(58) **Field of Classification Search** ..... 198/312,  
198/313, 315, 588, 594, 595, 812; 414/345,  
414/346; 193/35 TE  
See application file for complete search history.

(56) **References Cited**  
U.S. PATENT DOCUMENTS  
2,494,302 A 1/1950 Mason  
3,268,099 A \* 8/1966 Ajero et al. .... 198/523  
3,780,843 A \* 12/1973 McGovern et al. .... 193/35 TE  
3,876,060 A \* 4/1975 Stease ..... 193/35 TE  
4,663,919 A 5/1987 Stroh et al.  
4,733,767 A 3/1988 Anderson et al.  
5,193,660 A \* 3/1993 McKernan et al. .... 198/594  
5,584,376 A 12/1996 Voldby  
6,032,781 A 3/2000 Ballestrazzi et al.  
6,298,981 B1 10/2001 Hosch et al.

FOREIGN PATENT DOCUMENTS

WO WO-2005/073110 A1 8/2005

OTHER PUBLICATIONS

Powerstow, Power Stow Rollertrack Conveyor—Technical data, Flexramp, Oct. 17, 2005, 3 pages, <http://www.powerstow.com/rollertrack/technicaldata.html>.

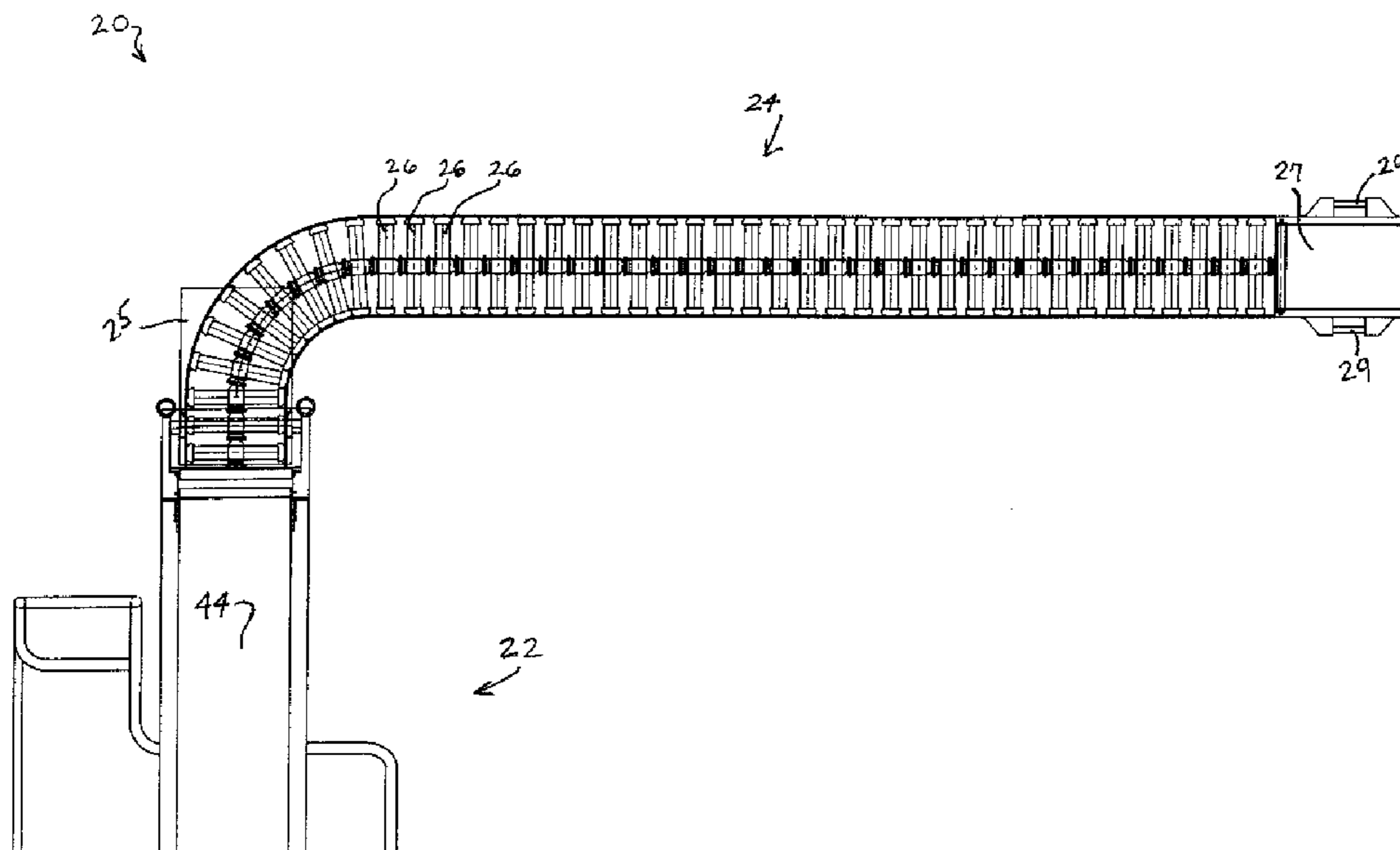
\* cited by examiner

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(57) **ABSTRACT**

A portable conveying device comprising an inclining base having a conveyor belt, a plurality of articulating conveying elements having powered cargo rollers defining a conveying device transport plane, the conveying elements extendable from and retractable into the base by drive means. The drive means may include a pair of spaced-apart spur gears which have teeth that engage with rack teeth of the conveying elements. The conveying device may include a hollow universal joint having axes of rotation lying substantially in the same plane.

**20 Claims, 16 Drawing Sheets**



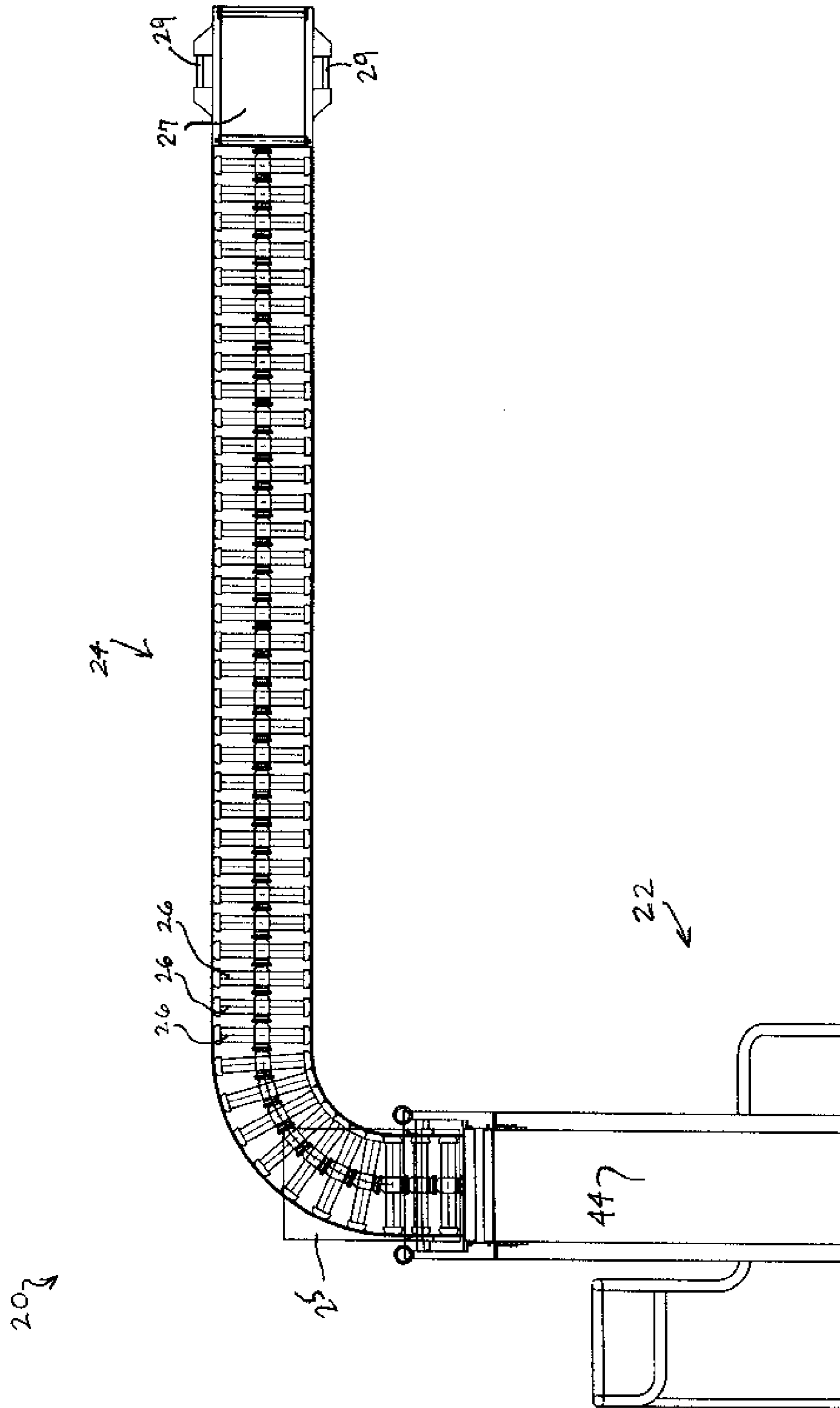


FIG. 1

207  
267

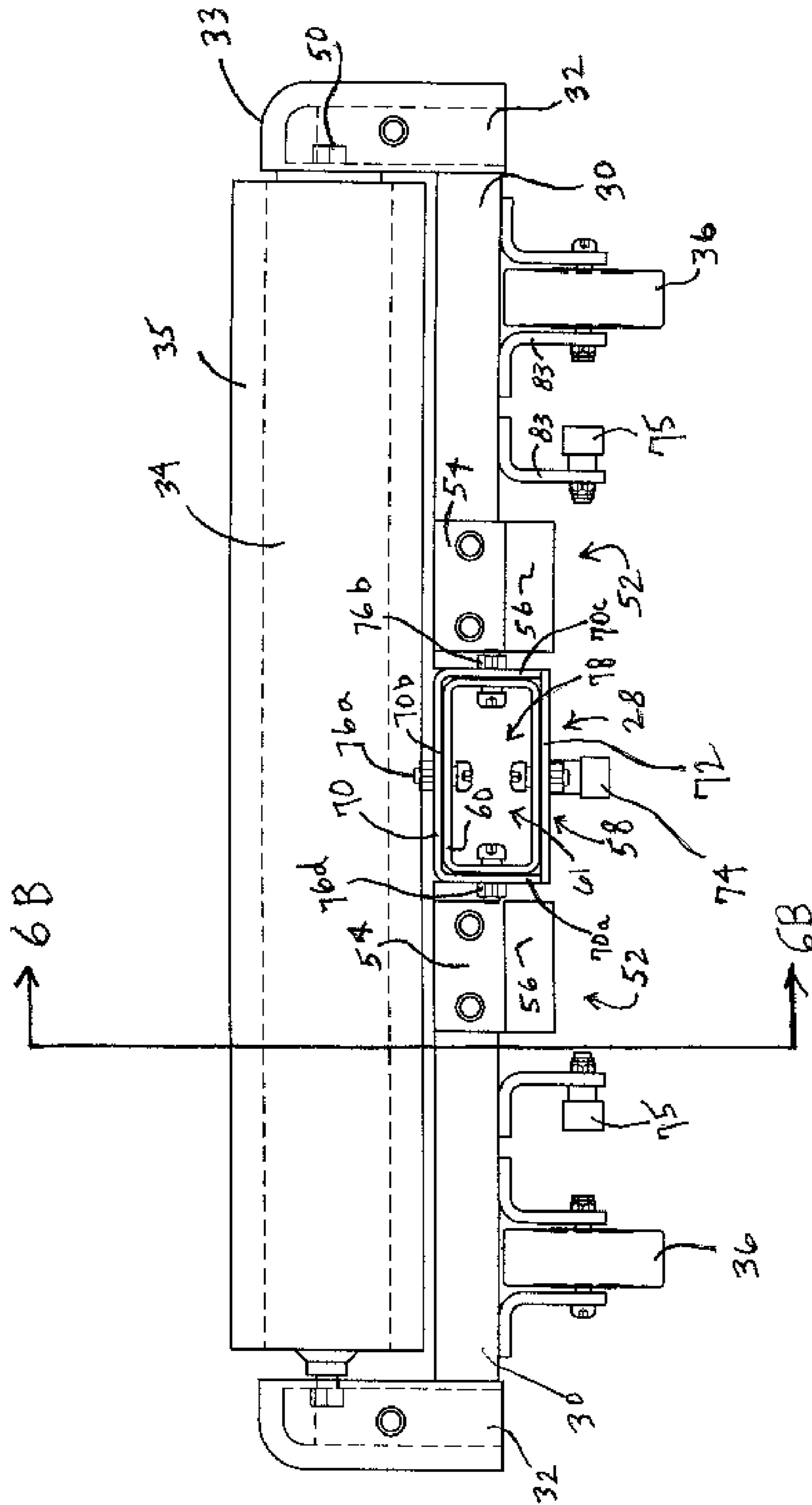


FIG. 2

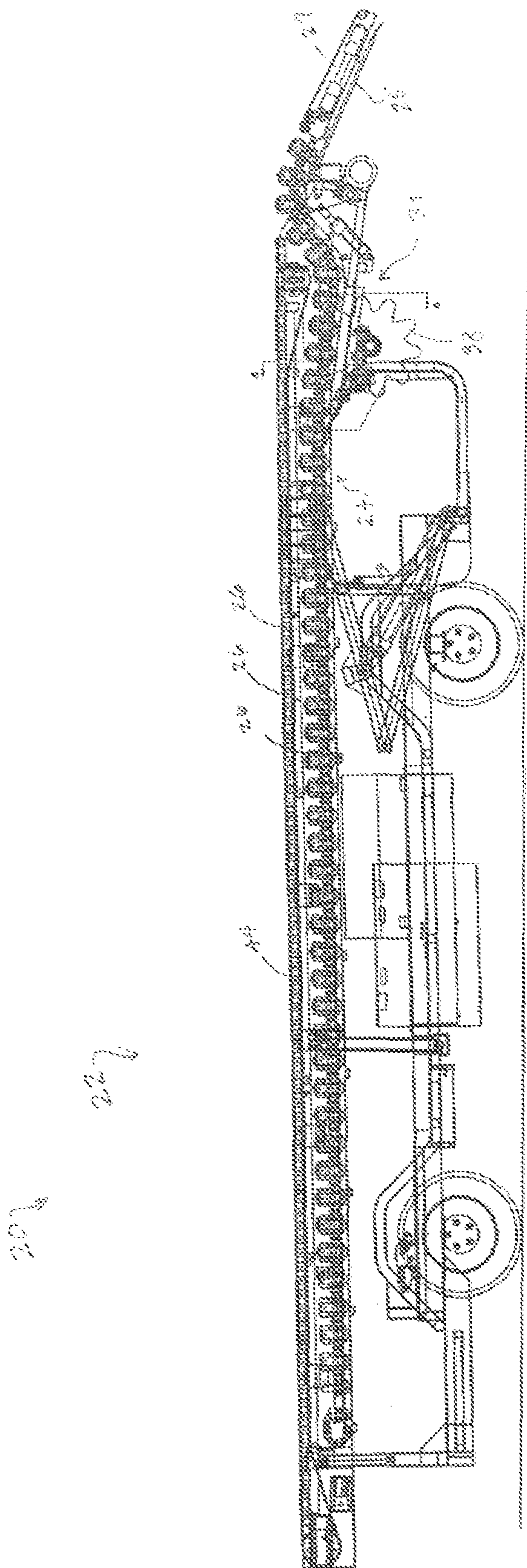


FIG. 3A

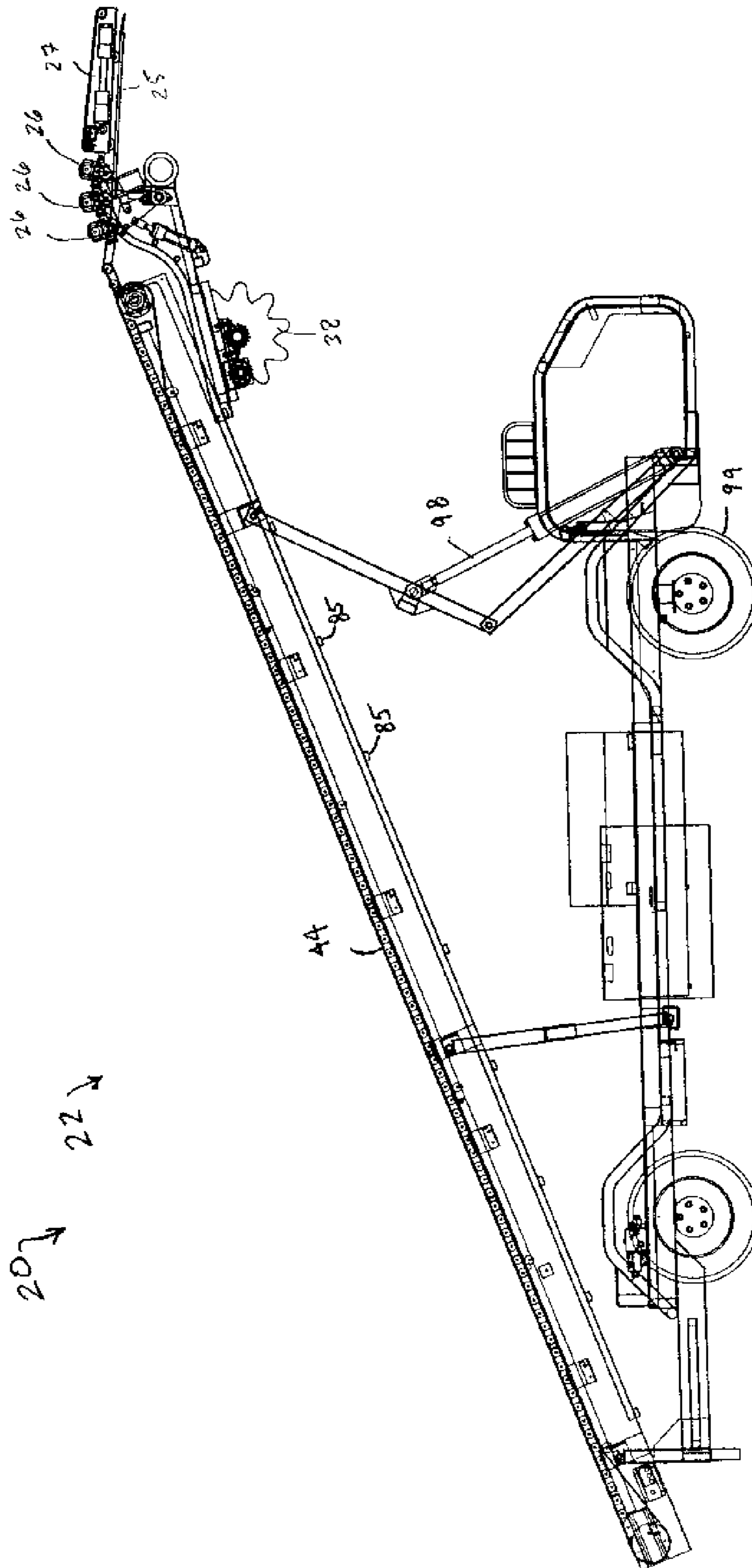


FIG. 3B

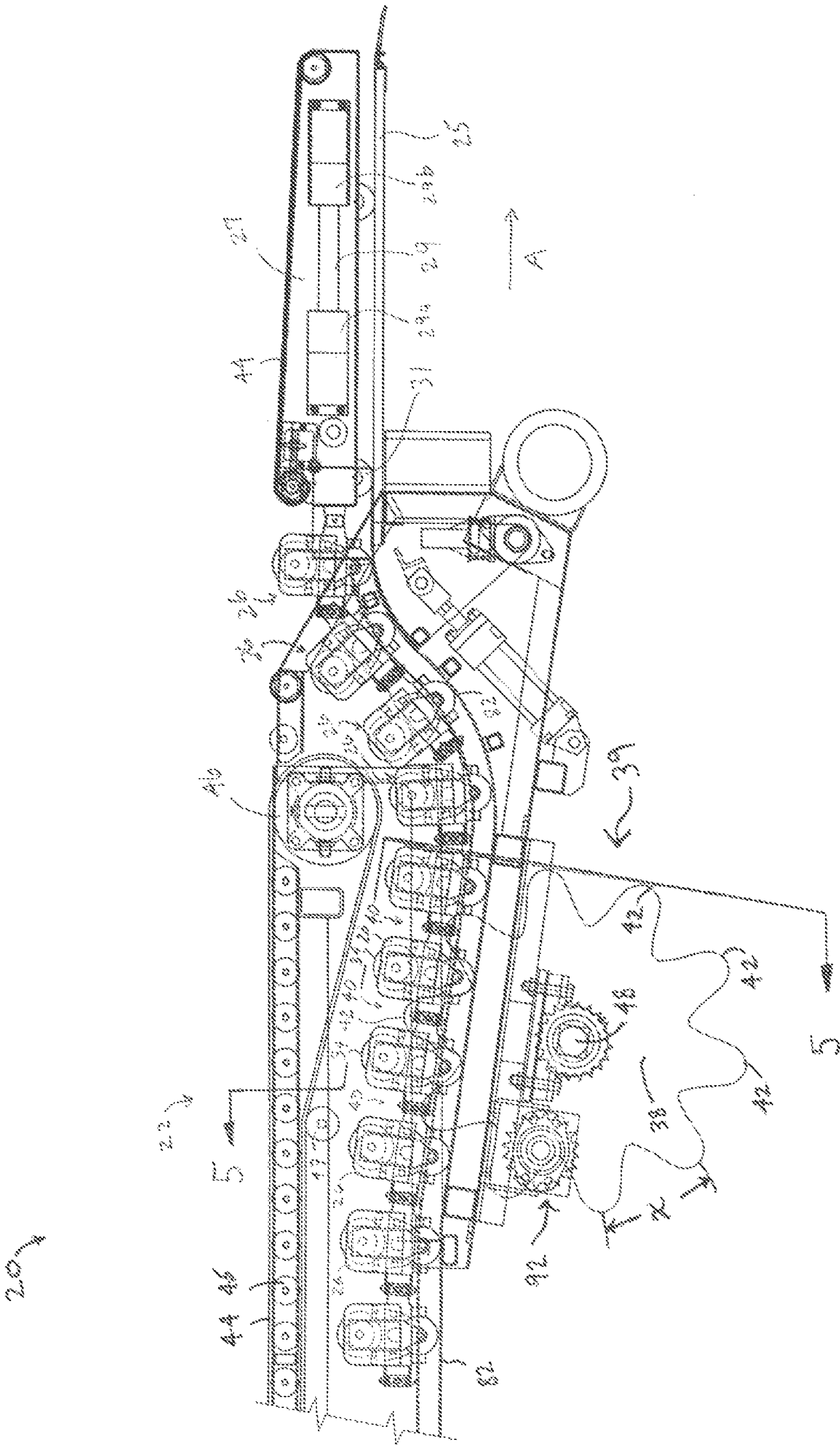


FIG. 4

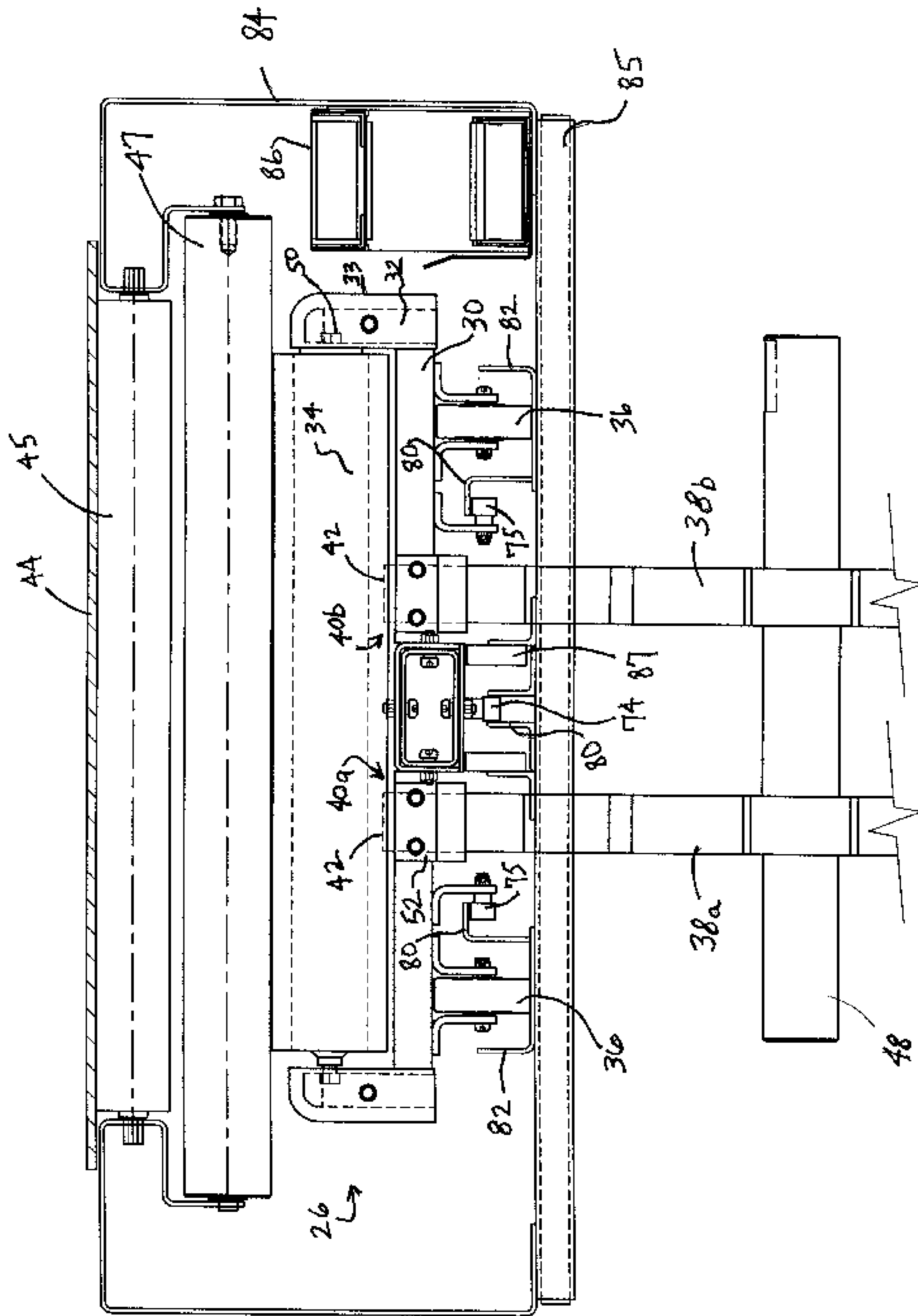


FIG. 5

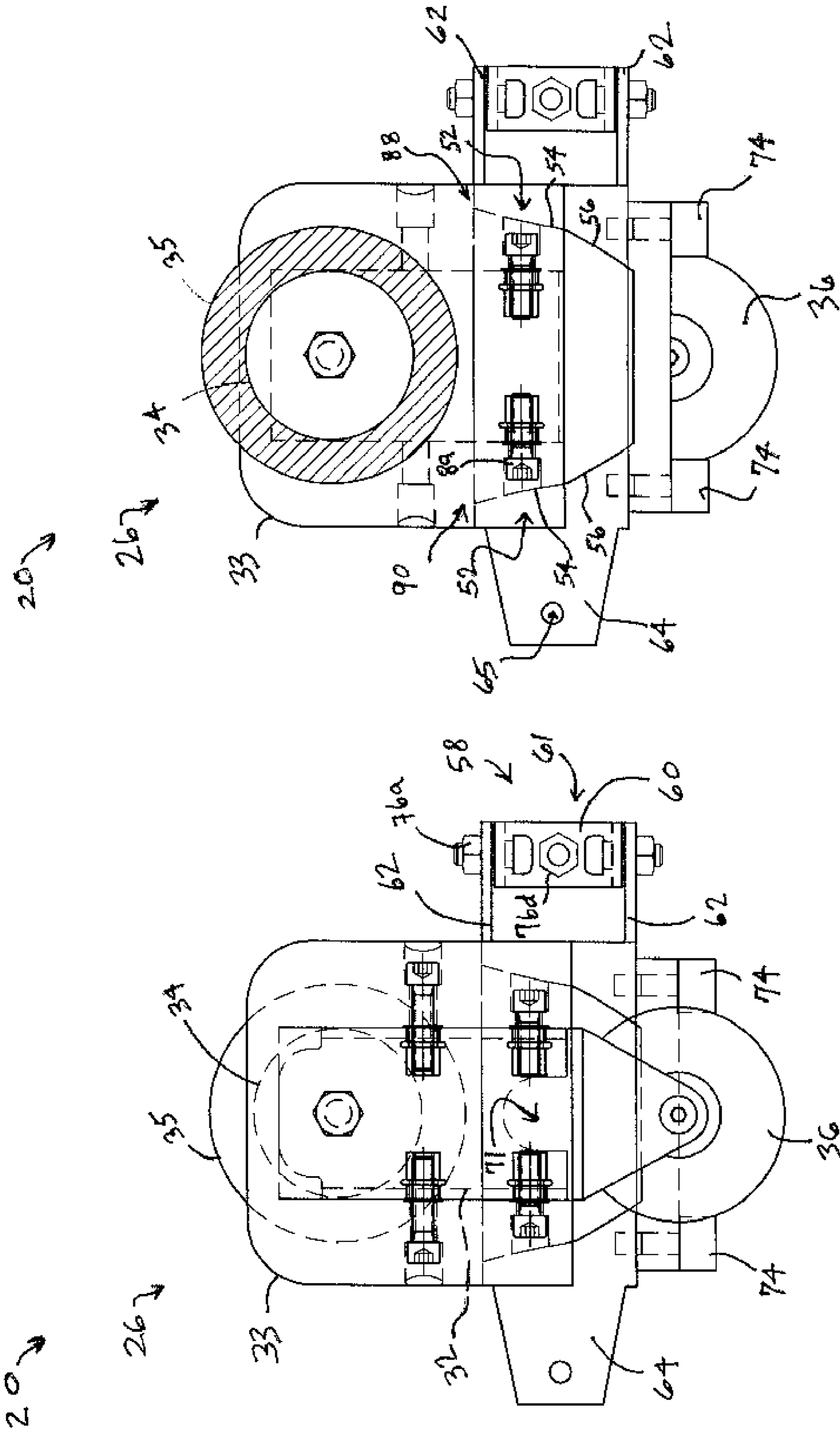


FIG. 6B

FIG. 6A



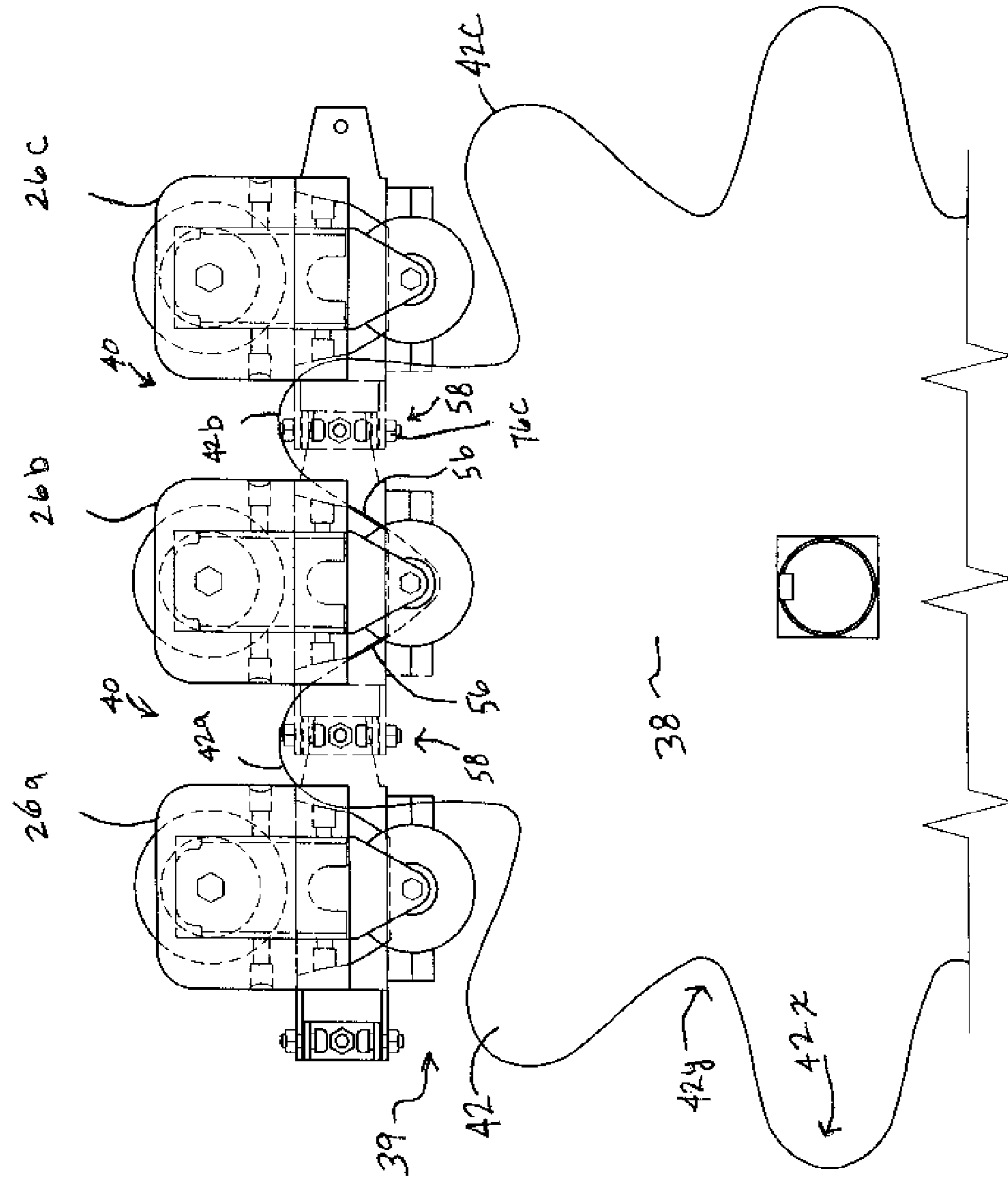


FIG. 7

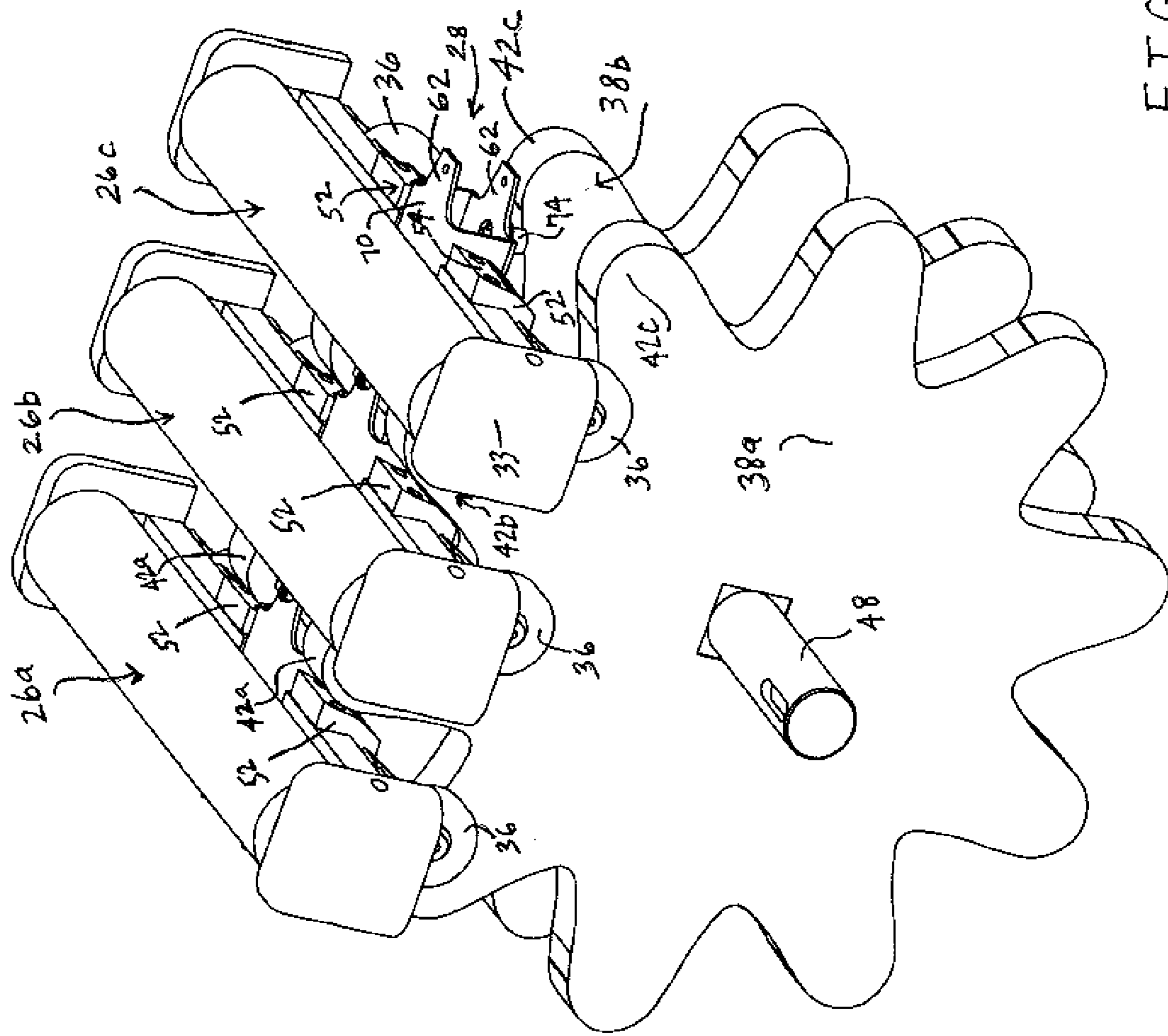


FIG. 8

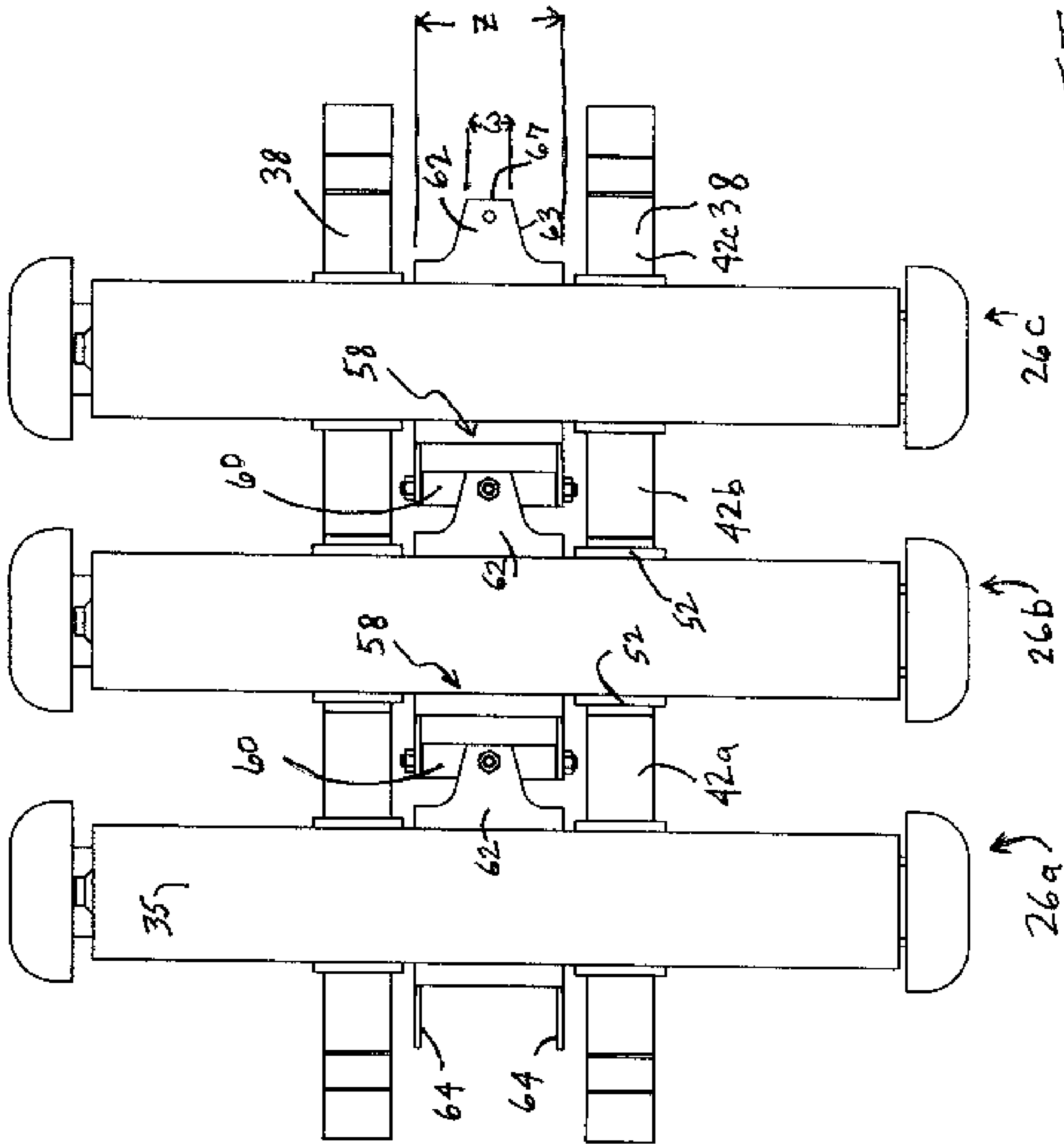


FIG. 9

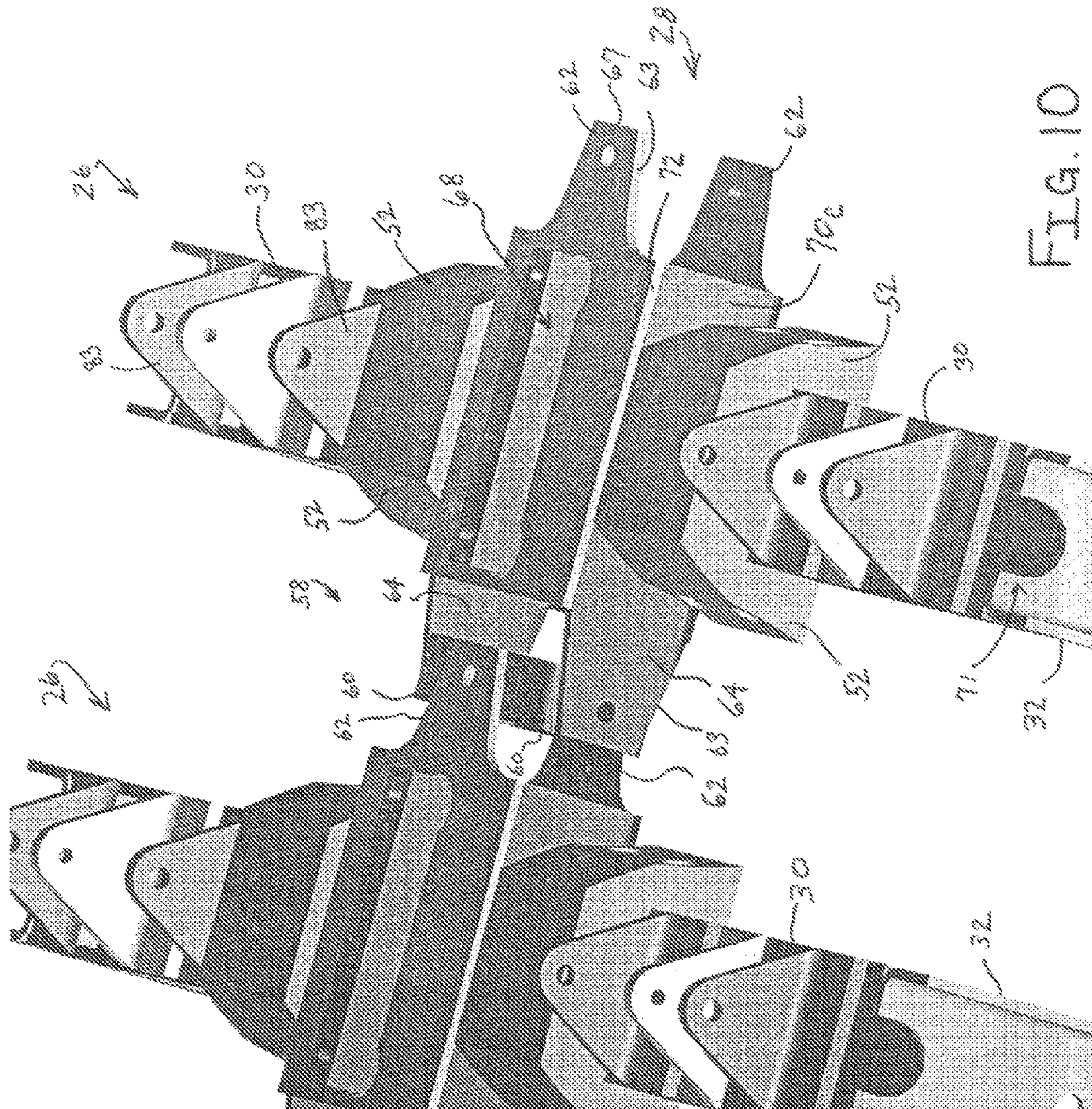


FIG. 10

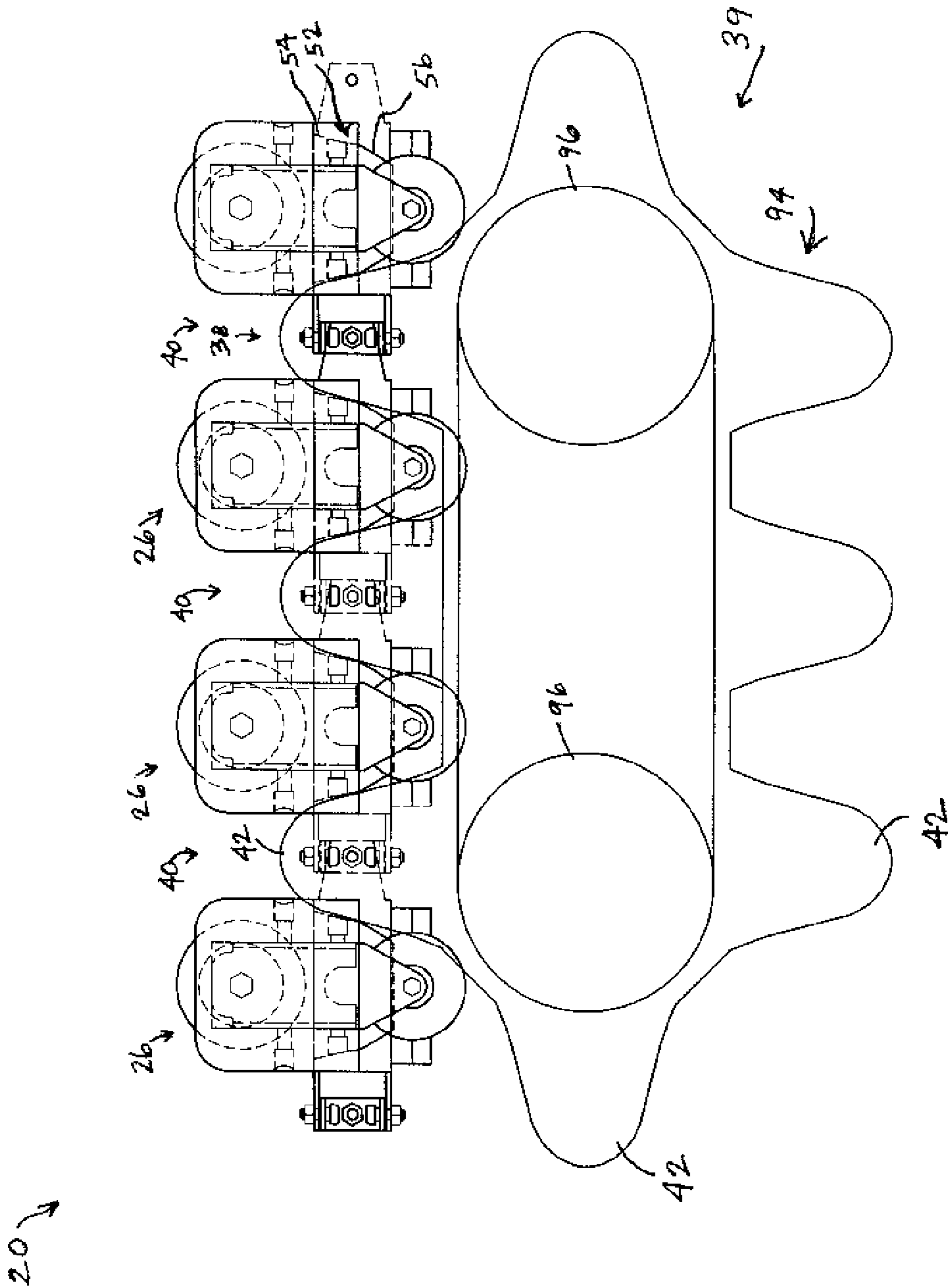


FIG. 11

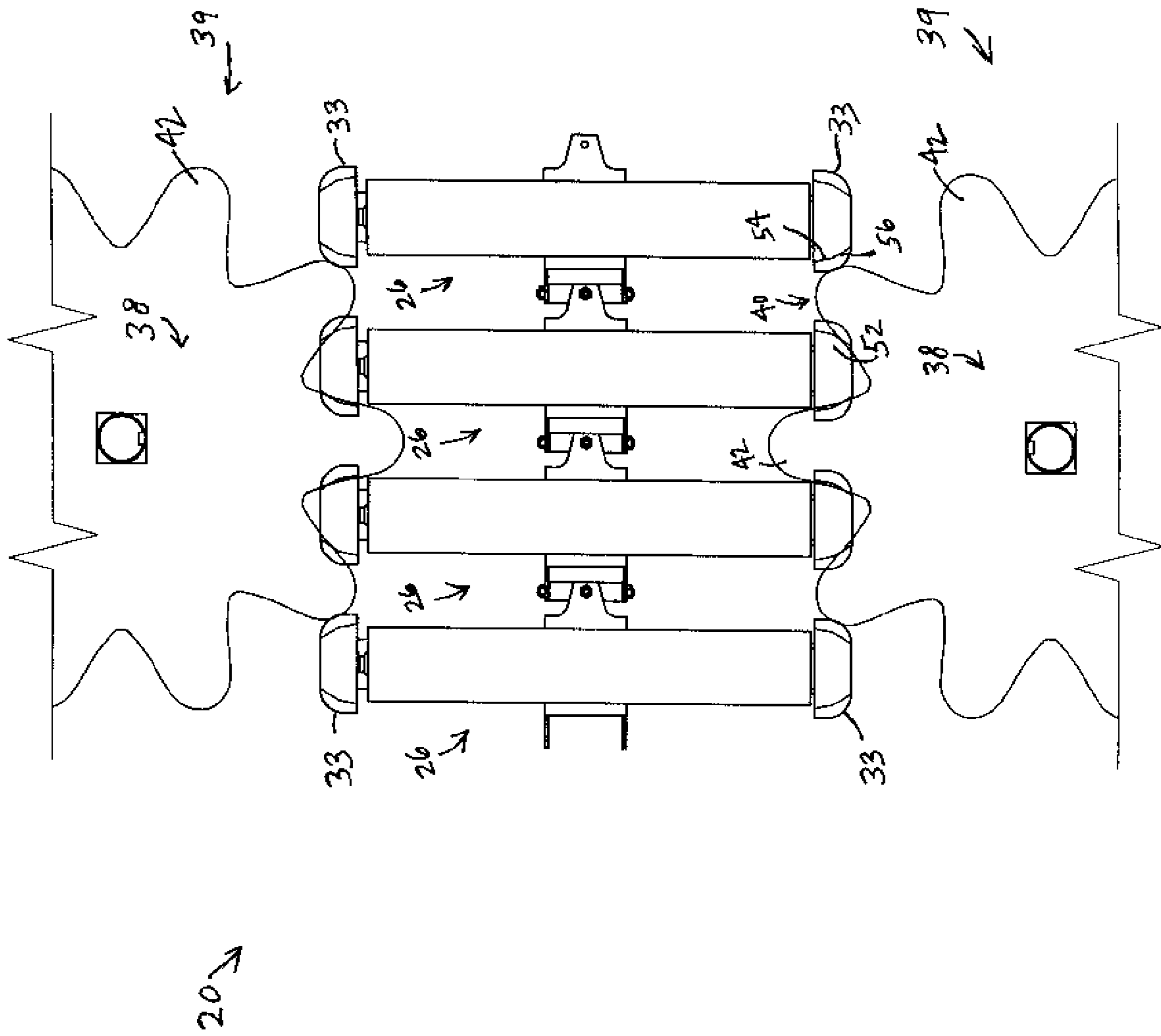


FIG. 12

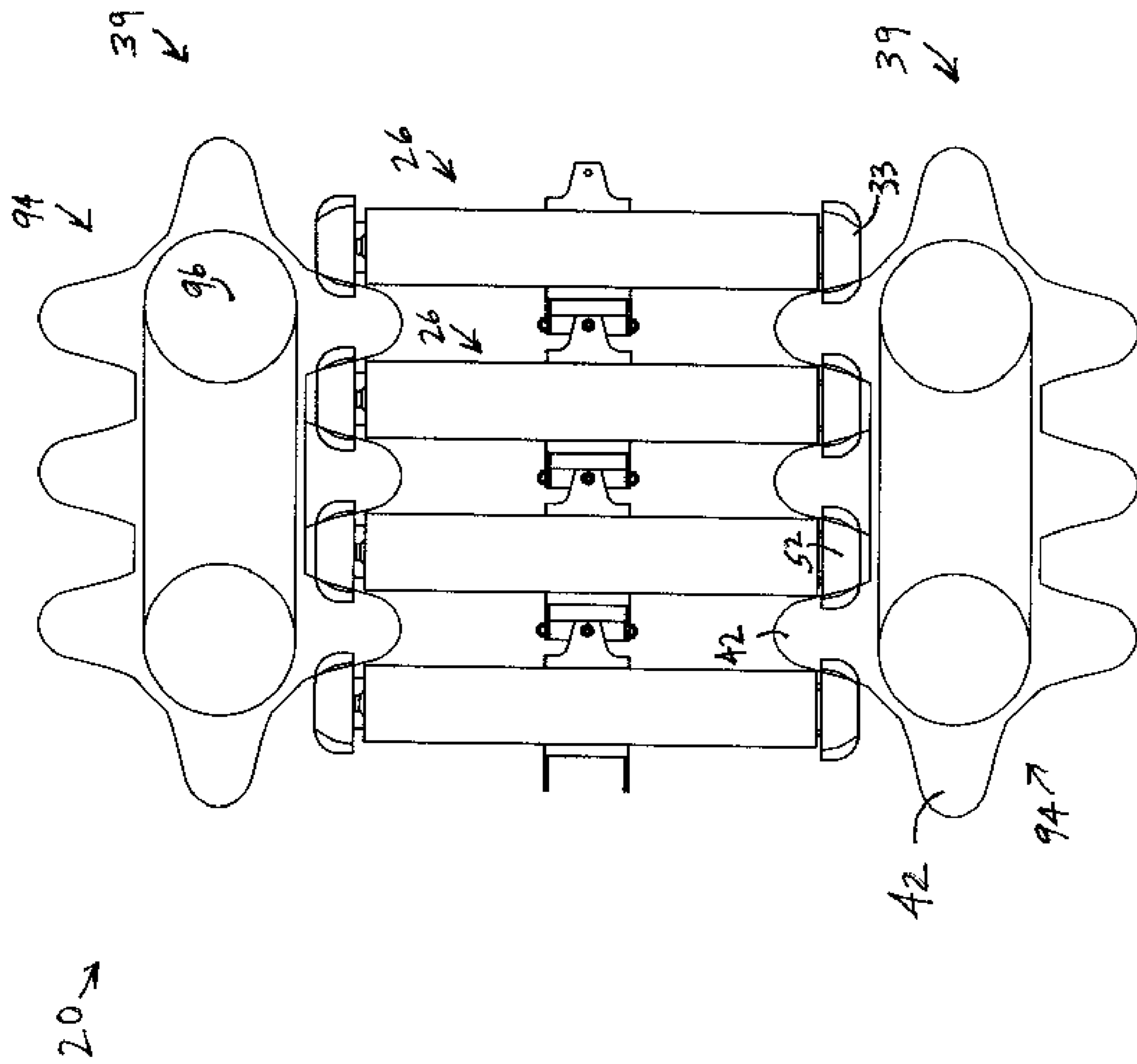


FIG. 13

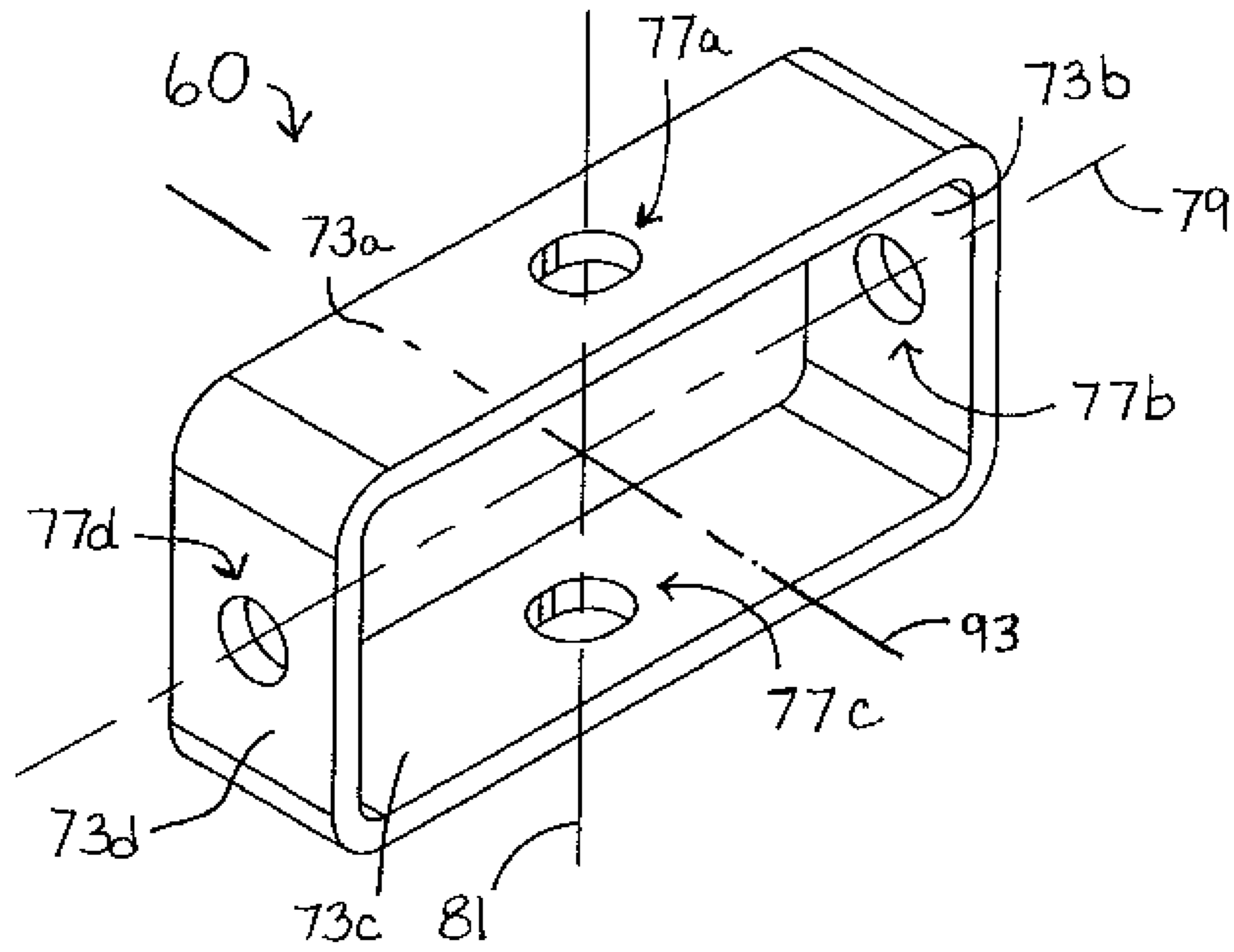


FIG. 14A

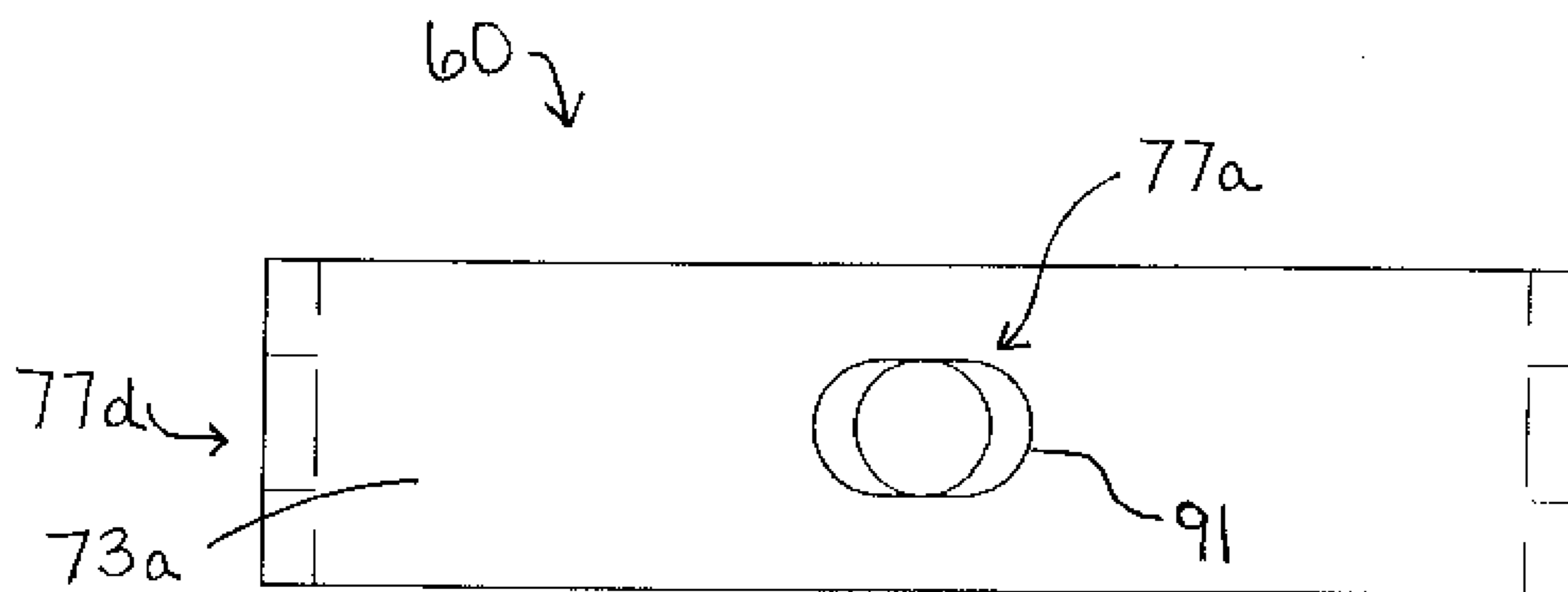


FIG. 14B



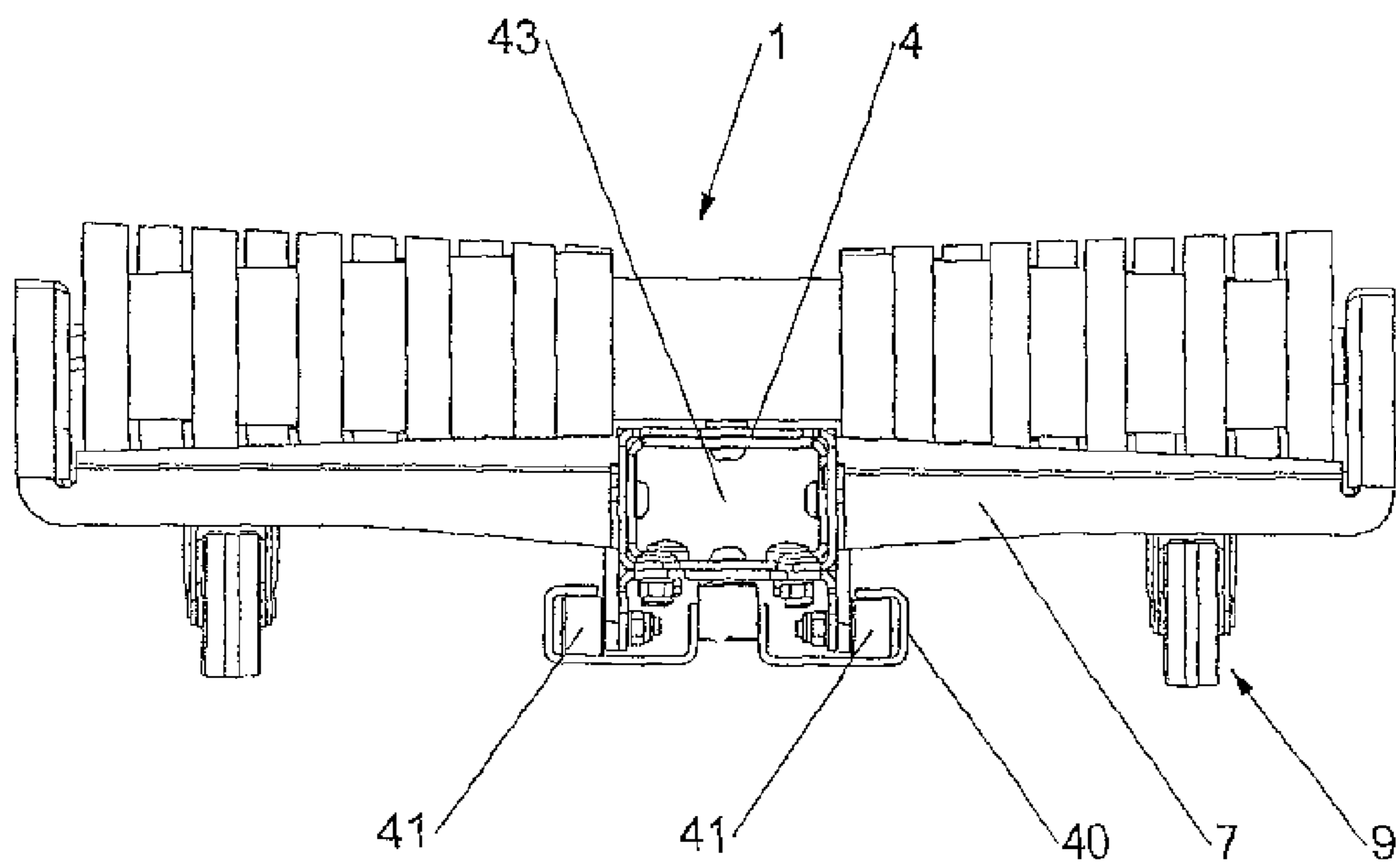


Fig. 15  
(PRIOR ART)

## 1

## CONVEYING DEVICE

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present invention relates generally to conveying devices, and more specifically to conveying devices having drive mechanisms to selectively extend and retract conveying elements, and particularly to conveying devices having drive mechanisms to selectively extend and retract conveying elements from an aircraft baggage loader.

## 2. Background Information

Baggage loading devices are common. A typical device includes a vehicle equipped with an endless belt upon which luggage or other items are placed. Movement of the belt conveys the luggage from one end of the vehicle to the other end. An airplane loading vehicle preferably elevates at an angle so the luggage is transported from a lower level and into higher positioned cargo area of the airplane. In some instances add-on conveyors are included with the main belt-driven loader.

One example of such an add-on conveyor is found in U.S. Pat. No. 5,584,376 to Voldby. The add-on conveyor in Voldby is generally positioned in a retracted state beneath the main belt loader of the apparatus. The conveyor may be extended into the cargo compartment of the aircraft. A user manually pushes the conveyor into position while an assistant in the cargo compartment guides the end of the conveyor. The conveyor can be withdrawn progressively by manually pulling the conveyor from the outside in the opposite direction. At least a certain number of the rollers of the conveyor may include driving means to power the rollers which in turn convey baggage or other items. The conveyor includes a flexible driving means, such as a cardan chain, which has two degrees of freedom, one along the curve and the other up/down in relation to a horizontal plane. Examples of such chain include the type "Uni-slat top" or "Uni-Flex", both from the firm Uni-Chains Int. A/S Vejle, Denmark. A chain of the latter type essentially consist of Y-shaped chained links, linked together so that the chain can be curved like a bike chain, but can also be bent sideways in a curve. The slat-variety includes elements with a slat of flattened surface that are linked together and have similar movement as a Y-shaped variety. Neither include a hollow opening disposed for running of cables within the chain-like structure.

Another example of a conveyor device is found in PCT Application Publication No. WO 2005/073110 A1 entitled Conveying Device, by Martin Vestergaard, published Aug. 11, 2005. The conveyor device in that application is silent as to whether and/or how the device is extended from or retracted into the aircraft or other base. The conveyor device in that application includes a variety of mechanisms for articulation of respective conveying elements. The device also includes an embodiment where the conveying device of that invention is arranged underneath the device for transporting the luggage from the cargo hold to the luggage trolley placed on the ground. This is done by arranging a box-like structure underneath the conveyor such that the conveying device according to that disclosure can slide out of and into that box-like structure. For that purpose, a guide rail is arranged inside the box such that the chain box elements 4 of the conveying device according to that disclosure may by means of guidance rollers roll inside the guide rail such that it is relatively easy to eject or insert the conveying device into the conveyor. While the device of Vestergaard shows a hollow chain box 4 as indicated in prior art FIG. 15 by reference number 43 for placing different means for powering the roll-

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ers, wires etc. (which FIG. 15 generally corresponds to FIG. 15 of the Vestergaard PCT application), such particular structure of FIG. 15 or disclosure does not show a universal joint for articulation to achieve two degrees of freedom.

Another example of a conveyor device in use outside the United States and generally demonstrated at www.powerstow.com includes a retractable conveyor having multiple rollers. This device is marketed by Power Stow A/S of Denmark under the name Rollertrack. The retraction and extension of the conveyor units appears to be powered; yet the specifics of how such motion is obtained, such as with a worm drive or jack screw or other mechanism, is not apparent from the disclosure. There is no disclosure of the conveyor units having a yoke for articulation to achieve two degrees of freedom or to swivel about two axes. What is apparent in the Rollertrack device, however, is the need for use of tracking rollers to fill a gap between the conveyor belt and the extending rollers.

Other examples of conveyor devices having a retractable conveyor are found in U.S. patent application Ser. No. 10/169,361 to Thogersen, publication No. US 2003/0091415, and U.S. patent application Ser. No. 10/720,471, publication No. US 2004/0105740. These applications show a retractable conveyor constructed for storing in a generally folded configuration. The retractable conveyor units include an endless belt. In one embodiment, the moving of the conveyor units to and from the cargo compartment of an aircraft is carried out by means of a driving, endless conveyor belt which cooperates with the bottom side of the conveyor units, such as by way of friction; or the conveyor part is pushed and moved into the cargo compartment; or the invention is generally silent as to the particulars of how the conveyor units are driven or retracted or extended. The pivoting of respective conveyor units requires a complicated design and accommodates pivoting in limited direction. For instance, the individual conveyor units pivot in a bottom-to-bottom relationship but do not freely pivot in a top-to-top relationship (i.e., they fold downward (bottom-to-bottom) with respect to each other but there is no showing that they fold top-to-top, or upward with respect to each other).

The present invention, however, provides a novel conveying device and advantages over prior designs. The device includes a drive mechanism which accommodates for ease of extension/retraction of the conveying elements of a conveyor. The conveying elements also include an advantageous hollow universal articulating joint for increased performance. Numerous other advantages and novel features of the present invention are disclosed.

## SUMMARY OF THE INVENTION

The present invention is directed toward a conveying device comprising at least a first conveying element comprising a supporting rail, a cargo roller positioned above the supporting rail, and the supporting rail having at least one rack tooth. The device may further include a drive means for engaging the rack tooth to drive the conveying element. A plurality of conveying element articulate with adjacent conveying elements. The drive means may include a spur gear, and preferably a pair of spaced apart spur gears to engage with a series of rack elements to accommodate retraction/extension of the retractable conveyor.

A further aspect of the invention includes a conveying device comprising at least a first spur gear, and at least two conveying elements each having a cargo roller, the at least two conveying elements defining a groove in which at least one tooth of the spur gears inserts. The device may further include

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at least one of the conveying elements having a supporting rail, the supporting rail having a rack element against which the at least one tooth abuts. A universal joint may connect adjacent conveying elements, with the universal joint being hollow to allow wires to be strung through the device to power the cargo rollers. The universal joint includes a yoke defining lines of axis lying generally on the same plane to accommodate a compact arrangement having desired degrees of movement.

A further aspect of the present invention includes a portable conveying device comprising an inclining base having a conveyor belt, a plurality of articulating conveying elements having powered cargo rollers defining a conveying device transport plane, the conveying elements extendable from and retractable into the base by drive means. The drive means may include a pair of spaced-apart spur gears which have teeth that engage with rack teeth of the conveying elements. The conveying device may include a hollow universal joint having axes of rotation lying substantially in the same plane.

The above summary of the present invention is not intended to describe each illustrated embodiment, aspect, or every implementation of the present invention. The figures and detailed description that follow more particularly exemplify these and other embodiments and further aspects of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be more completely understood in consideration of the following description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. 1 is a plan view of a conveyor made in accordance with the present invention.

FIG. 2 is a front elevation view of a conveyor and conveying element of the present invention.

FIG. 3A is an elevation view of a conveyor of FIG. 1 with a retractable conveyor portion retracted and with portions of a base conveyor removed for clarity.

FIG. 3B is an elevation view of the conveyor of FIG. 1 with belt conveyor elevated and with portions of the unit removed for clarity.

FIG. 4 is a partial elevation view of the conveyor of FIG. 3.

FIG. 5 is a section view taken along line 5-5 of FIG. 4

FIG. 6A is a left side elevation view of the conveyor and element of FIG. 2.

FIG. 6B is a section view taken along line 6B-6B of FIG. 2.

FIG. 7 is a partial elevation view of the conveyor of FIG. 3 with portions removed for clarity.

FIG. 8 is a partial perspective view of a conveyor of the present invention with portions removed for clarity.

FIG. 9 is a partial plan view of the conveyor of FIG. 8.

FIG. 10 is a partial bottom perspective view of components of a conveyor of the present invention.

FIG. 11 is a partial elevation view of a further aspect of the present invention.

FIG. 12 is a partial plan view of a further aspect of the conveyor of the present invention.

FIG. 13 is a partial plan view of a further aspect of the conveyor of the present invention.

FIG. 14A is a perspective view of a yoke component of the present invention.

FIG. 14B is a top view of a further aspect of the yoke component.

FIG. 15 is an elevation view of a prior art device.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by

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way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not necessarily to limit the invention of the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention and as defined by the appended claims.

#### DETAILED DESCRIPTION OF THE INVENTION

The invention is directed to a portable conveyor comprising an inclining base having a conveyor belt, a plurality of articulating conveying elements having powered cargo rollers defining a conveying device transport plane, the conveying elements extendable from and retractable into the base by drive means. The drive means may include a pair of spaced-apart spur gears which have teeth that engage with rack teeth of the conveying elements. The conveying device may include a hollow universal joint having axes of rotation lying substantially in the same plane.

Referring now to FIG. 1, a conveyor according to the present invention is generally depicted with reference to numeral 20. In one aspect, conveyor 20 includes a base 22 and a retractable conveyor 24. Base 22 is preferably a belt conveyor as is common in the aircraft ground support equipment environment. Typically base 22 includes a conveyor belt 44 which typically includes an endless belt driven by a head stock pulley 46 and supported by multiple conveyor belt rollers 45. Belt 44 travels over return idler 47 as is commonly understood. A variety of conveyor belt devices may be used in conjunction with the present invention. While preferable, it may be appreciated that base 22 need not be limited to a conveyor belt mechanism.

In FIG. 1, retractable conveyor 24 is depicted in an extended position. It may be appreciated that conveyor 24 may be placed within the cargo hold of an aircraft for transport of cargo items (cargo not shown). Retractable conveyor 24 includes a number of conveying elements 26 which articulate with respect to adjacent elements 26 and accommodate extension of conveyor 24 into various positions. Conveyor 20 preferably includes a docking platform 25 intended to rest within the cargo hold area of an aircraft. Front end conveying element 27 is preferably positioned on platform 25 when in a retracted state. Each of conveyor 20, base or belt conveyor 22, retractable conveyor 24 and conveying element 26 are conveying devices as that term is used herein.

Referring to FIG. 2, conveyor 20 includes at least one conveying element 26. Conveyer element 26 includes a wire harness box 28 formed generally of a box channel plate 70 and box plate 72. Alternatively, a hollow section tube may be used. Box channel plate 70 is generally U-shaped and when fitted with box plate 72 forms a generally rectangular channel 78 preferably running the length of wire harness box 28. Box channel 78 accommodates for running of power or control wires (not shown) the length of conveyor 20. Conveying element 26 includes supporting rail 30. Preferably conveying element 26 has a pair of supporting rails 30 affixed on either side of wire harness box 28. Supporting rails 30 are preferably welded to wire harness box 28. Supporting rail 30 includes shoulder 32 which is preferably a channel or U-shaped and extends upwards from rail 30. Shoulders 32 on each end of conveying element 26 support cargo roller 34. Cargo roller 34 rotates to convey items such as cargo. Sleeve 35 is placed over cargo roller 34 for desired circumference and traction. Inside cargo roller 34 is a powering means, such as a motor (powering means and motor not shown) for rotating roller 34. Typically powering means is an electric motor. Wires (not

shown) for powering electric rotation motor are fed through box channel 78, along supporting rail 30, along shoulder channel 32 and preferably through hollow bolt 50. Supporting rail 30 includes transport roller 36, generally affixed opposite cargo roller 34. Preferably conveying element 26 includes at least two transport rollers 36. Transport rollers 36 allow element 26 to roll upon an aircraft cargo bed (not shown) or other surface. Wire harness box 28 includes at least one guiding roller 74 which is configured to roll within guide rail 80 (see FIG. 5) and to align and guide conveying element 26 in an out of base 22. Supporting rail 30 preferably includes guidance rollers 75 which also roll within guide rail 80 to assure transport rollers 36 of conveying element 26 roll upon track 82 (see FIG. 5) of base 22. It may be appreciated that track 82 runs at least substantially the length of base 22. Preferably rectangular tube 85 is included to provide support to conveyor 22. Preferably UHMW material 87 is positioned along the assembly of conveying elements 26 to accommodate smooth extraction/retraction. Preferably UHMW material has general dimension of 1/2 inch thick by 1 1/2 inches wide and conveniently spaces or allows box 28 to be aligned. UHMW material 87 preferably runs the length of the assembly of elements 26 to prevent tipping and maintaining level positioning of elements 26.

Conveying element 26 includes at least one rack tooth 52. Rack tooth 52 is preferably affixed to supporting rail 30. It may be appreciated that rack tooth 52 may be integrally connected with rail 30. As shown in FIG. 6B, rack tooth 52 includes rack wall 54 and rack lower wall 56. Preferably rack wall 54 has a concave cross-section and rack lower wall 56 has a convex cross-section. Such concave and convex cross-section accommodate for improved driving of conveying element 26 to retract or extract conveying element 26 from a base 22. Preferably rail 30 includes a rack tooth 52 at a front side 88 and at a rear side 90 of rail 30. More preferably rack tooth 52 is a single unit that wraps from front side 88 to rear side 90 of rail 30 as shown in FIG. 6B. Preferably rack tooth 52 is fastened into rail 30 with fastening means 89 such as a bolt or the like.

FIG. 3 is an elevation view of conveyor 20 with a retractable conveyor portion 24 retracted. Conveyor 20 includes base 22 which may preferably be a belt conveyor. Portions of a base conveyor have been removed for clarity. Multiple conveying elements 26 are stored beneath conveyor belt 44 and are extracted or driven by drive means 39. As shown in FIG. 4, drive means 39 includes a spur gear 38 having fingers 42. Adjacent conveying elements 26 define grooves 40. Finger 42 inserts into groove 40 and upon rotation of spur gear 38, drives a conveying element 26. Preferably finger 42 abuts rack tooth 52. As finger 42 rotates it preferably successively abuts both rack wall 54 and rack lower wall 56. Such action accommodates efficient driving of conveying elements 26.

As shown in FIG. 5, conveyor 20 preferably includes two spur gears 38. Each spur gear engages with a respective series of rack teeth defined by the individual rack tooth 52 of conveying elements 26. Preferably each spur gear 38 is affixed to a spur gear shaft which is rotatably affixed to base 22. Preferably spur gear 38 has a generally square center bore to mate with shaft 48 which is preferably made of square stock to lock spur gear 38 and to keep spur gear 38 from slipping about shaft 48. Preferably spur gears 38a, 38b are spaced apart to engage rack tooth 52 on either side of wire harness box 28 to accommodate efficient driving of conveying elements 26.

While drive means 39 is preferably hydraulically powered, it may be appreciated that drive means may also be electrically powered. Preferably hydraulic drive means 39 includes a hydraulic motor and brake mechanism 92 to prevent back

flow of elements 26 when conveyor 20 is in an elevated position. The brake 92 includes a brake release valve, which when hydraulically powered, allows for release of the brake and subsequent movement of the conveying elements 26.

Spur gear 38 may be made of a variety of metals or other items, and preferably spur gear 38 is made of a nylon type of ingredient such as those that may contain nylon and molybdenum disulphide such as Nylatron® GSM, or is made of phenolic or a synthetic resin type of material. Preferably fingers 42 are spaced apart or have a "pitch" generally shown by the arrow X of FIG. 4. Preferably the pitch is about 6 inches. Preferably spur gear 38 has a pitch diameter of about 19 inches. Preferably spur gear 38 is positioned toward a front end of conveyor 20 to accommodate efficient extraction/retraction of conveyor 24.

FIG. 6A and FIG. 6B show conveyor 20 from an elevation view. FIG. 6A includes conveying element 26 with shoulder 32 extending generally upward from supporting rail 30. Preferably shoulders 32 are welded to rails 30. Shoulders 32 preferably include a wire channel 71 to receive wires running from wire harness box 28 to power cargo roller 34. Preferably at least two guiding rollers 74 are positioned on either side of transport rollers 36 to accommodate for efficient alignment within guide rail 80.

Conveyor 20 includes means for pivoting 58 about at least two and preferably three axes. Preferably each conveying element 26 includes a U-joint or universal joint 58 to accommodate for multiple degrees of motion so that elements 26 may articulate with respect to each other and from side-to-side and over surfaces having varying undulations. Preferably universal joint 58 is a "hollow" U-joint in that it has a hollow space to accommodate insertion of wires through conveying element 26. Preferably universal joint 58 includes means for pivoting, or yoke 60. Preferably yoke 60 has a generally rectangular cross section and a hollow center or yoke channel 61. More preferably yoke 60 is a tube-like structure. Preferably yoke 60 has an outer dimension less than or equal to an inner dimension of wire harness box 28 as shown in FIG. 2.

Yoke 60 is preferably a rectangular shaped swivel component having apertures 77a-77d located preferably on each of its four faces 73a-73d as generally shown in FIG. 14A. Preferably face 73a is opposite and parallel to face 73c, and face 73b is opposite and parallel to face 73d. Preferably each yoke face 73a, 73b, 73c, and 73d include an aperture 77 positioned substantially at a center portion of the respective faces 73. Axis 79, which is generally a horizontal axis, generally runs through apertures 77b and 77d; and axis 81, which is generally a vertical axis, generally runs through apertures 77a and 77c. Preferably axis 79 and axis 81 lie on a common plane. Positioning on a common plane accommodates for a more compact design of universal joint 58. More preferably axis 79 intersects with axis 81 at a center portion of yoke channel 61. Such centralized alignment accommodates for more efficient and more uniform swiveling of respective conveying elements 26. It may be appreciated that each pair of apertures accommodates insertion of fasteners 76a-76d to allow for pivoting about respective fasteners. For instance, fasteners 76a and 76c accommodate pivoting about vertical axis 81 to accommodate a generally side-to-side pivoting of respective elements 26. Such side-to-side pivoting is best shown in general along the curve of retractable conveyor 24 in FIG. 1. Fasteners 76b and 76d accommodate pivoting about a horizontal axis 79 to accommodate a generally up-and-down pivoting between respective elements 26. Such up-and-down pivoting is best shown in general in FIG. 4 as elements 26 curve vertically along track 82. This side-to-side and up/down motion of elements 26 is referred to as having two degrees of

freedom, one along the curve and the other up/down in relation to a horizontal plane. More particularly, universal joint **58** has at least two degrees of freedom, and preferably three degrees of freedom (i.e., joint **58** pivots or allows for pivoting about at least two axes, and preferably three axes as stated below).

As shown in FIG. **14B**, yoke **60** preferably has opposing apertures **77a** and **77c** which lie generally on vertical axis **81**. Preferably, apertures **77a** and **77c** are elongated or oval shaped or otherwise have a slot **91**. Slot **91** is somewhat exaggerated in its scope of elongation for demonstration. Oval shaped apertures **77a** and **77c** allow conveying elements to rotate or twist about axis **93** which runs generally normal to axis **79** and axis **81**, and generally longitudinally through center of yoke **60**. Slot **91** allows for a third degree of freedom, namely rotational freedom. As such, conveying element **26** is allowed to rotate about the above-referenced longitudinal axis **93**, and transport roller wheels **36** which lie on either side of wire harness box **28** may accommodate travel over varying or uneven surfaces by means of rotation or movements due to slot **91**. It may be appreciated that slot **91** allows for a certain amount of "slop" and that rotation or movement is not confined to rotation or movements about axis **93** but may vary depending on the case. Preferably means for pivoting **58** and **60** accommodates range of motions of, for instance, up/down of plus/minus about 36 degrees, side-side of plus/minus about 12 degrees, and rotation of plus/minus about 2.4 degrees. It may be appreciated that side-side motion may be limited by bumpers **33**.

Rotation about axis **79** allows adjacent conveyors **26** to be pivoted such that respective cargo rollers **34** may either draw closer together or further apart depending upon the undulation of rail **82** or of the undulation of a cargo hold, platform or other surface. It may be appreciated that use of such universal joint **58** may accompany a variety of conveying devices and is not limited to those devices having a drive means **39** as recited but may be used in conjunction with other mechanisms that might employ a worm drive or jack screw drive or other mechanism to extend conveying elements.

Conveying element **26** includes generally opposing front tabs **62** and generally opposing rear tabs **64**. Rear tabs **64** align with yoke **60** at faces **73b**, **73d** while adjacent conveying element **26** has front tabs **62** which align with yoke **60** at faces **73a**, **73c**. Tabs **62**, **64** are aligned and rotatably fastened at apertures **65** and through box fastener apertures **77b**, **77d**. As best shown in FIG. **9** and FIG. **10**, tabs **62**, **64** are tapered (such as at tapered edge **63**) to accommodate articulation or swivel to achieve a desired range of motion of respective conveying elements **26**. Preferably terminating end **67** has a width *w* less than a width *z* of harness box **28** and yoke **60**. It may be appreciated that adjacent conveying elements may freely articulate while at the same time cables (cables not shown) may be strung through yoke channel **61** and box channel **78**. Preferably wire harness box **28** includes access port **68** to accommodate access to cabling that runs through wire harness box **28**. Preferably, harness box **28** is modular such that successive harness boxes **28** may be connected to and/or interchanged with adjacent harness boxes **28**.

FIG. **10** is a bottom perspective view of the invention with various parts removed for clarity. A variety of roller flanges **83** project from an underside of rails **30** for attachment of rollers **36**, **75**. Shoulders **32** extend upward from rails **30**. While rack tooth **52** is shown to straddle rail **30**, it may be appreciated that rails **30** may be of wider dimension so that rack tooth **52** is an integral part of rail **30**.

As shown in FIG. **7**, FIG. **8** and FIG. **9**, conveying elements **26a**, **26b**, and **26c** are connected with respective universal

joints **58**. Finger **42a** inserts into groove **40**. A portion of finger **42a** engages rack lower wall **56** of element **26b** while another portion of finger **42a** preferably engages with rack wall **54** of element **26a**. Likewise, finger **42b** engages with rack lower wall **56** of element **26b** while another portion of finger **42b** preferably engages with rack wall **54** of element **26c**. It may be appreciated that as gear **38** rotates either clockwise or counter-clockwise, various portions of fingers **42** will engage with various portions of rack teeth **52** to thereby drive or otherwise retract or extract elements **26**. Fingers **42** are designed with crests **42x** and valleys **42y** to match grooves **40** and rack teeth **52** for a smooth driving motion of elements **26**.

FIG. **3B** shows one typical example of a conveyor **20** where base **22** is a belt conveyor having scissors lift. Scissors lift **20** includes an actuator **98** for inclining conveyor belt **44** relative to a relatively horizontal position as shown in FIG. **3A**. Conveyor **20** preferably is a vehicle and includes wheels **99** or other transporting means to transport conveyor **20** from place to place. Preferably conveyor includes docking platform **25** upon which front end conveying element **27** may rest. Preferably docking platform **25** rotates to accommodate leveling of element **27** and to allow for flush engagement of platform **25** with an aircraft cargo floor or other surface. Preferably, conveyor includes a leveling sensor and/or controller to automatically adjust the level of platform **25** to accommodate placement at the area of entry of platform **25** into the aircraft. Leveling mechanism includes a hydraulic bleed to allow platform **25** to move freely or to float into desired position. Once platform is sensed to be in a level position relative to a cargo entry area, elevation movement of conveyor **22**, such as a scissors conveyor, ceases automatically.

Preferably element **27** includes an endless belt conveyor **44**, which also may preferably include a flap to be raised or lowered to accommodate various angles for unloading cargo. Handle **29** slides within handle blocks **29a**, **29b** to operate extraction or retraction of elements **26**, **27**. As a user grasps and slides handle **29** in the direction of arrow A (FIG. **4**), switches or controls activate drive means **39** which operates by rotating in a clockwise direction to extend element **27** in the direction of arrow A. Element **27** preferably includes drive roller **31** which preferably extends substantially the width of element **27** and rotates as handle **29** slides. Drive roller **31** is preferably powered by an electric drive motor. Drive roller **31** assist in smooth extraction of elements **26** which may otherwise compress upon adjacent elements **26** causing retractable conveyor **24** to otherwise buckle or misalign. In retraction mode, drive roller **31** may be unpowered and rotate freely to allow drive means **38** to control retraction. Element **27** may also include a control area (not shown) for housing control mechanisms and systems for operation of the various belts, rollers and drive mechanisms of conveyor **20**.

In operation, after conveyor **20** is positioned adjacent an aircraft and platform **25** is leveled to the cargo hold area, a user extracts retractable conveyor **24** by grasping handle **29** and extending the conveyor to the cargo hold area. Handle **29** operates drive means **39** which powers, for instance, spur gear **38** and may also power drive roller **31**. As spur gear **38** rotates, individual fingers **42** engage with respective grooves **40** defined by the plurality of conveying elements **26**. Fingers **42** abut rack teeth **52** for efficient driving of elements **26**. Guiding roller **74** and guidance rollers **75** operate to maintain elements **26** on track **82**. Individual elements **26** swivel as they travel over undulations such as the curved track **82** and further swivel from side-to-side as desired to enter various cargo hold areas. The method of operation includes providing

a conveyor **20** as described herein, positioning the conveyor **20** adjacent an aircraft, extracting conveyor **24**, and placing cargo upon conveyor **24**.

Referring to FIG. **11**, a further aspect of the conveyor **20** is shown. Cog belt **94** rotates about cog belt shaft **96** where fingers **42** successively engage within respective grooves **40** to drive conveying elements **26**. Fingers **42** are configured to engage with rack tooth **52** and to match generally concave rack wall **54** and generally convex rack lower wall **55**. A pair of cog belts **94** may be provided on either side of wire harness box **28** so as to have fingers **42** engage with at least two rack tooth **52** of each supporting rail **30**. Cog belt **94** may have multiple fingers **42** and may span to engage with more than one groove **40**. Cog belt **94** is preferably made of a rubberized material so that fingers **42** which operate similar to treads may flex as they travel around cog belt shaft **96** into driving position.

Referring to FIG. **12**, a further aspect of the conveyor **20** is shown. Drive means **39** includes a pair of spaced apart spur gears **38** arranged at respective ends of elements **26**. Bumpers **33** operate as rack tooth **52** having rack wall **54** and rack lower wall **56**. Fingers **42** engage bumpers **33** to drive elements **26**. As spur gears **38** rotate, elements **26** are extended from or retracted to base **20**. With reference to FIG. **13**, a further aspect of the invention is shown, where drive means **39** includes cog belts **94**. As belts **94** travel about shaft **96**, fingers **42** engage with bumpers **33** having rack tooth **52** to drive elements **26**.

The terms and descriptions used herein are set forth by way of illustration only and are not meant as limitations. Those skilled in the art will recognize that many variations are possible within the spirit and scope of the invention as defined in the following claims, and their equivalents, in which all terms are to be understood in their broadest possible sense unless otherwise specifically indicated.

What is claimed is:

1. A conveying device comprising:
  - at least a first conveying element comprising:
    - a supporting rail;
    - a cargo roller positioned above said supporting rail; and
    - said supporting rail having at least one rack tooth, where said supporting rail is substantially parallel to an axial direction of said cargo roller.
2. The device of claim **1** wherein said supporting rail includes a shoulder and at least one transport roller, said cargo roller affixed to said shoulder.
3. The device of claim **1** wherein said device includes a wire harness box, said supporting rail affixed to said wire harness box.
4. The device of claim **1** further comprising a drive means for engaging said rack tooth and driving said conveying element.
5. The device of claim **4** wherein said drive means is one selected from the group consisting of a gear, a spur gear, and a clog belt.
6. The device of claim **1** further comprising a base, a drive means affixed to said base, and a second conveying element, said drive means for driving said first and said second conveying elements from said base.
7. The device of claim **1** wherein said supporting rail includes a rack tooth on a front side and on a rear side of said supporting rail.
8. The device of claim **1** wherein said rack tooth includes an upper rack wall having a generally concave cross-section and lower rack wall having a generally convex cross section.

9. The device of claim **1** further comprising:
 

- a portable vehicle having a base, said base having a conveyor belt;

at least a first and a second spur gear rotatably affixed to said base; and

a plurality of articulating conveying elements having powered cargo rollers, said conveying elements extendable from said base, said conveying elements defining a plurality of grooves in which teeth of said first and second spur gears engage to operatively extend and retract said conveying elements.

10. A conveying device comprising:

at least a first spur gear;

at least two conveying elements each having a cargo roller, said at least two conveying elements defining a groove in which at least one tooth of said spur gear inserts; and at least one of said conveying elements has a supporting rail,

where said supporting rail is substantially parallel to an axial direction of said cargo roller.

11. The device of claim **10** where said supporting rail having a rack element against which said at least one tooth abuts.

12. A conveying device comprising:

at least a first spur gear;

at least two conveying elements each having a cargo roller, said at least two conveying elements defining a groove in which at least one tooth of said spur gear inserts; and

a universal joint connecting said at least two conveying elements, said universal joint including a yoke having a hollow rectangular cross section.

13. The device of claim **12** wherein said yoke includes apertures defining a vertical axis and a horizontal axis and wherein said vertical axis and said horizontal axis lie substantially in the same plane.

14. A conveying device comprising:

a base;

at least a first spur gear rotatably affixed to said base; and

at least two conveying elements extendable from said base and each including a cargo roller, at least one of said conveying elements has a supporting rail substantially parallel to an axial direction of said cargo roller associated with said conveying element, said at least two conveying elements defining a groove in which at least one finger of said spur gear inserts.

15. The device of claim **14** wherein said base includes a conveyor belt.

16. The device of claim **14** further comprising a second spur gear rotatably affixed to said base wherein at least one finger of said second spur gear inserts within a second groove defined by said at least two conveying elements, said first and said second spur gears affixed to a common shaft.

17. The device of claim **14** wherein said first spur gear has a diameter of about 19 inches and includes a plurality of fingers with a pitch of approximately six inches between said fingers.

18. The device of claim **14** wherein said base includes an actuator for providing inclination of a continuous belt, said device further including a plurality of conveying elements positioned beneath said belt, said device further including powering means for rotating said cargo rollers.

19. A conveying device comprising:

a base;

at least a first conveying element having a supporting rail and a cargo roller positioned above said rail, said supporting rail having a rack element;

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a drive means for engaging with said rack element to extend said first conveying element from said base, where said supporting rail is substantially parallel to an axial direction of said cargo roller.

**20.** The device of claim **19** wherein said drive means 5 includes a spur gear rotatably affixed to said base, said rack

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element having a rack wall against which a tooth of said gear engages, said base further including an actuator for inclining said base, and said drive means includes a hydraulic brake.

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